Islamic University of Gaza
Water Resources Management
EENV 4359
First Semester (2014-2015)
Allowable time 60 minutes

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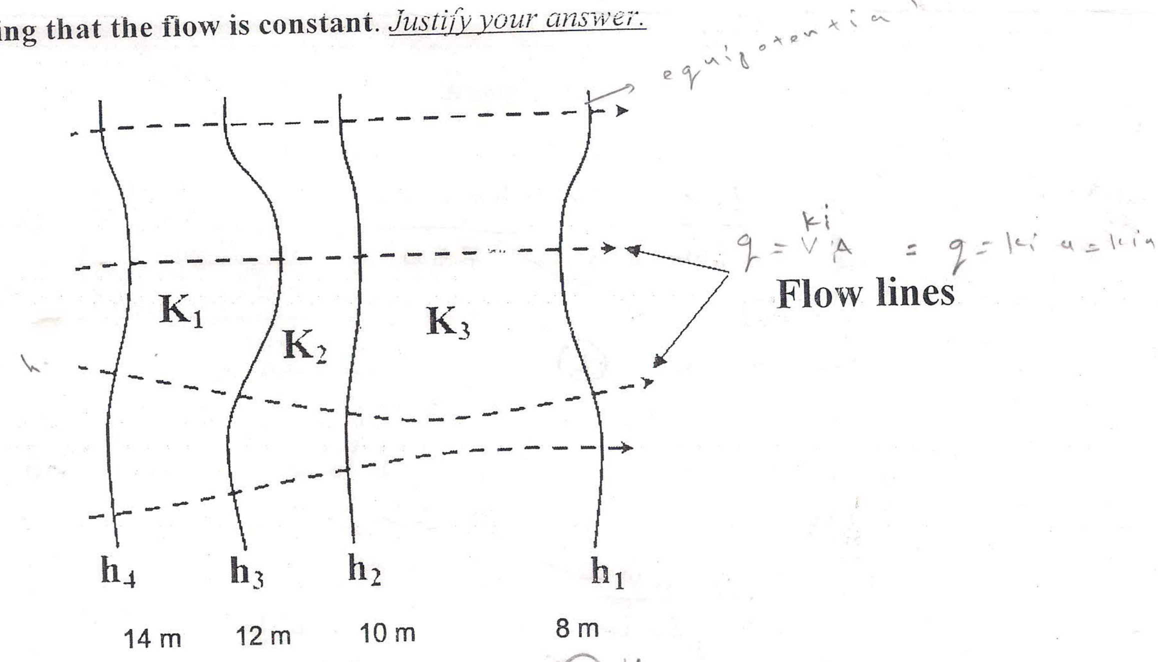
CLOSED BOOK EXAM

Student Name:

Q1	4	4
Q2	5	5
Q3	5	7 -2
Q4	13	14 -1
Total	27	30

Question 1 (4 Marks) 4

The figure shows a contour map of a confined aquifer, which shows equipotential lines as well as the flow lines. The aquifer is heterogeneous as indicated by the different K values. Consider that $h_4 - h_3 = h_3 - h_2 = h_2 - h_1 = 2$ m. **Rank the K values from the smaller to the higher considering that the flow is constant.** <u>Justify your answer.</u>



$q @ k_1 = q @ k_2 = q @ k_3$

$k_1 i A = k_2 i A = k_3 i A$

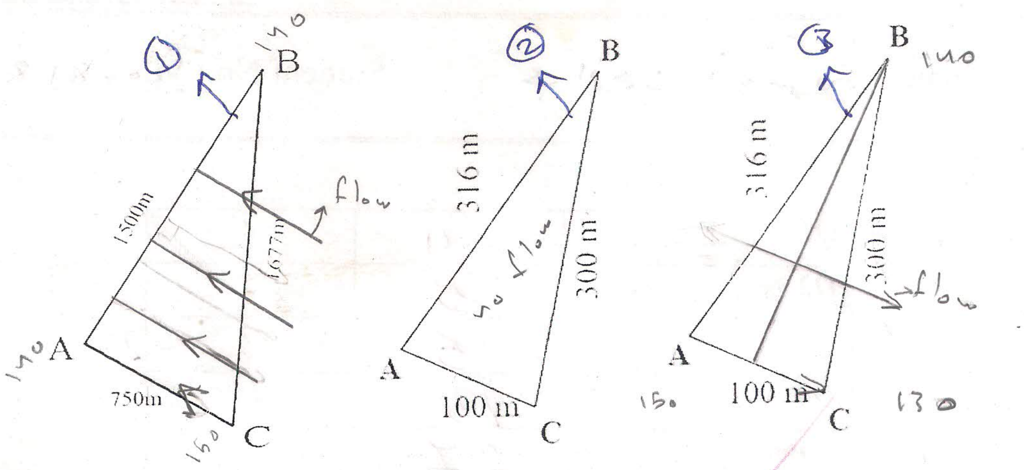
$k_1 \frac{2}{\text{المسافة}} = k_2 \frac{2}{\text{المسافة}} = k_3 \frac{2}{\text{المسافة}}$

$\frac{k}{L}$ = constant so $k_3 > k_1 > k_2$

$k \propto L$

Question 2: **(5 Marks)** 5

Determine both the direction of water movement and the gradient of the flow from the figures below. Each case is comprised of three points with heads as measured in the field.



Case I	Case II	Case III
h_A = 140 m	h_A = 140 m	h_A = 150 m
h_B = 140 m	h_B = 140 m	h_B = 140 m
h_C = 150 m	h_C = 140 m	h_C = 130 m

قائم الزاوية

Tringle (1) is ∟ @ A

flow in figure

$i = \frac{\Delta h}{\Delta L} = \frac{150-140}{750} = 0.013$

triangle (2)

there is no flow becaus no head difference

$i = \frac{\Delta h}{\Delta L} = 0$

قائم

Tringle (3) is ∟ @ A

flow in figure

$i = \frac{\Delta h}{\Delta L} = \frac{10}{50} = 0.2$

Question 3:

(7 Marks) 5

A soil sample (30 cm diameter × 400 mm height) is obtained from a research facility. The soil sample is weighed and placed in an oven to dry, after which it is reweighed. Water loss is 9,766 cm^3 and dry bulk density = 1.30 g/cm^3. Assume a particle density of 2.65 g/cm^3.

Calculate the following:

a) V_{air} solid w void

b) Porosity

c) Saturation degree, and **Indicate if this soil from saturated or unsaturated zone.**

$V_{total\ before\ dry} = \frac{\pi \times 30^2}{4} \times 40 = 28260\ cm^3$

$V_w = 9.766\ cm^3$

$W_{solid\ dry} = 1.3$

الكثافة = الوزن / ح

$V_{after\ dry} = 28260 - 9.766 = 28250.234\ cm^3$

weight of dry solid = 1.3 × 28250.234 = 36725.3042 g

volume of solid = $\frac{36725.3042}{2.65}$ = 13858.6 cm^3

V. of air = 28250.234 − 13858.6 = 14391.7 cm^3

$\alpha = \frac{V_v}{V_{total}} = \frac{9.766 + 14391.7}{28260} = 0.5096$

$S = \frac{9.766}{9.766 + 14391.7} = 6.781 \times 10^{-4}$

الكثافة = الوزن / حجم

الكثافة = v

v = w/p

Question 4: **(14 Marks)** 13

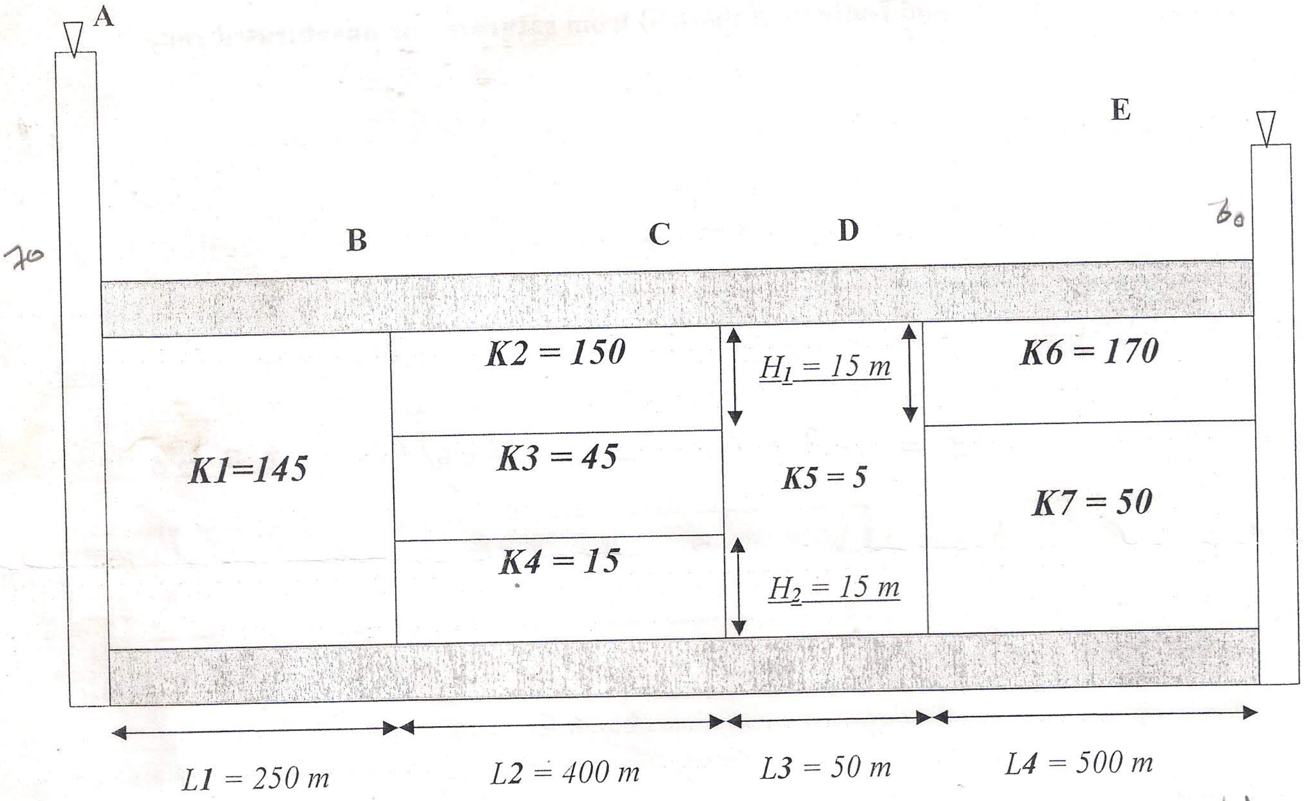
A confined aquifer has a constant thickness of 45 m, and stratified between two observation wells (A & E) as shown in the figure below. The piezometric head of A and E equal 70 m and 60 respectively. **Determine the following:**

a) The Transmissivity of the aquifer?

b) The flow per uint width of the aquifer.

c) The piezometric head at B, C and D.

assume k m/d



$k_8 = k_{eq\,2,3,4} = \dfrac{150 \times 5 + 45 \times 5 + 15 \times 5}{45} = 70.3$ m/d

$k_9 = k_{eq\,6,7} = \dfrac{170 \times 15 + 50 \times 30}{45} = 90$ m/d

$k_{eq\,1,8,5,9} = \dfrac{250 + 400 + 50 + 500}{\frac{250}{145} + \frac{400}{70.3} + \frac{50}{5} + \frac{500}{90}}$ 34.4

$= 35.28$ m/d

$T = Kb = 52.83 \times 45 = 2334.8544 \ m^2/d$

$q = KiA = -34.83 \times \frac{60 - 70}{1200} \times 45 \times 1 = 19.53 \ m^3/d.m$

head @ B   A → B   K = 145

$19.53 = -52.83 \times 45 \times \frac{h_B - 70}{250}$

$h_B = 67.91 \ m$

-1

head @ C   B → C → K = 70

$19.53 = -52.83 \times 45 \ \frac{h_c - 70}{650}$

$h_c = 64.58 \ m$

head @ D   C → D   K = 5

$19.53 = -52.83 \times 45 \ \frac{h_d - 70}{700}$

$h_D = 64.16 \ m$

Formulae Sheet

$$K_z = \frac{z_1 + z_2 + \cdots + z_n}{\frac{z_1}{K_1} + \frac{z_2}{K_2} + \cdots + \frac{z_n}{K_n}}$$

$$Q = m\,q = \frac{Kmh}{n}$$

$$K_x = \frac{K_1 z_1 + K_2 z_2 + \cdots + K_n z_n}{z_1 + z_2 + \cdots + z_n}$$

$$T = \frac{nQ}{mh}$$

$$\alpha = \frac{V_v}{V} = \frac{V_t - V_s}{V_t}$$

$$K = \frac{\alpha L^2}{ht}$$

$$q = \frac{K}{2x}\left(h_0^{\,2} - h^2\right)$$

$$h^2 = h_a^{\,2} + \frac{W}{K}\left(a^2 - x^2\right)$$

$$h^2 = h_1^{\,2} - \frac{\left(h_1^{\,2} - h_2^{\,2}\right)x}{L} + \frac{W}{K}(L - x)x$$

$$q_x = \frac{K\left(h_1^{\,2} - h_2^{\,2}\right)}{2L} - W\left(\frac{L}{2} - x\right)$$

$$d = \frac{L}{2} - \frac{K}{W}\frac{\left(h_1^{\,2} - h_2^{\,2}\right)}{2L}$$

$$Q = 2\pi K b \frac{h - h_w}{\ln\left(r/r_w\right)}$$

$$T = \frac{Q}{2\pi\left(s_1 - s_2\right)}\ln\frac{r_2}{r_1}$$

$$T = Kh_0 = \frac{Q}{2\pi\left[\left(s_1 - \frac{s_1^2}{2h_0}\right) - \left(s_2 - \frac{s_2^2}{2h_0}\right)\right]}\ln\frac{r_2}{r_1}$$

$$h_0^2 - h^2 = \frac{W}{2K}\left(r^2 - r_0^2\right) + \frac{Q_w}{\pi K}\ln\frac{r_0}{r}$$

$$K = \frac{Q}{\pi\left(h_2^2 - h_1^2\right)}\ln\frac{r_2}{r_1}$$

$$h = -\frac{vx}{K}$$

$$Bulk.density = \frac{Solid.wieght}{T.volume}$$

$$\text{Saturation Degree} = \frac{\text{Volme of Water}}{\text{Volume of Voids}}$$